Atomic Oxygen Cleaning of Unpainted Plaster Sculptures

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"Expert Meeting" on the Cleaning of Unpainted Plaster Sculptures

May 8th -9th, 2017 at the Ny Carlsberg Glyptotek, Copenhagen, Denmark

Gypsum/Plaster of Paris Composition

Gypsum/Plaster of Paris is a crystalline mineral of hydrated calcium sulphate

$$CaSO_4 \cdot 2H_2O$$

Atomic Oxygen Removal of Organic Surface Contaminants

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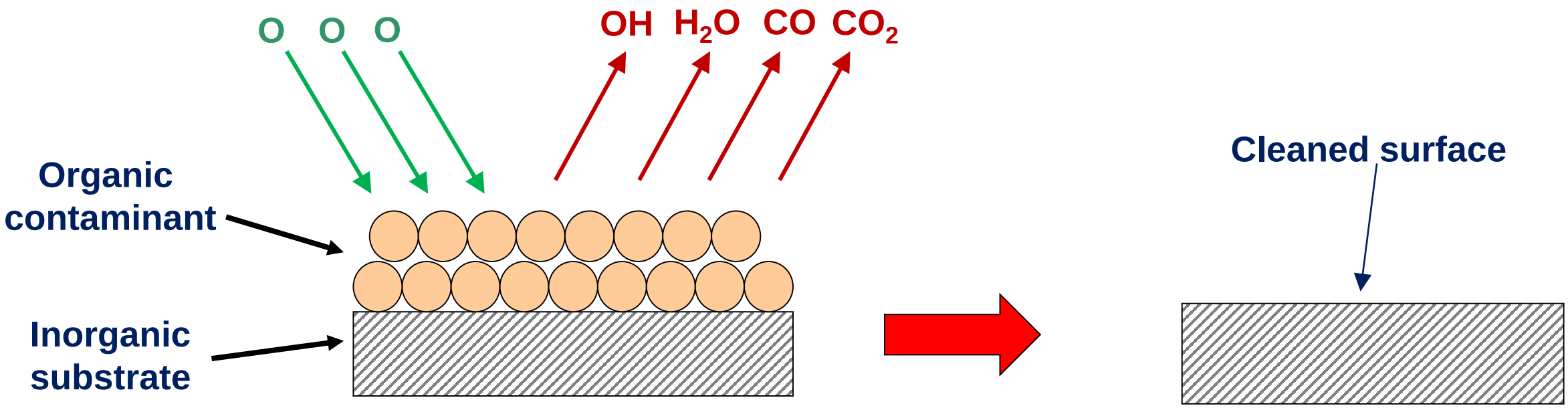
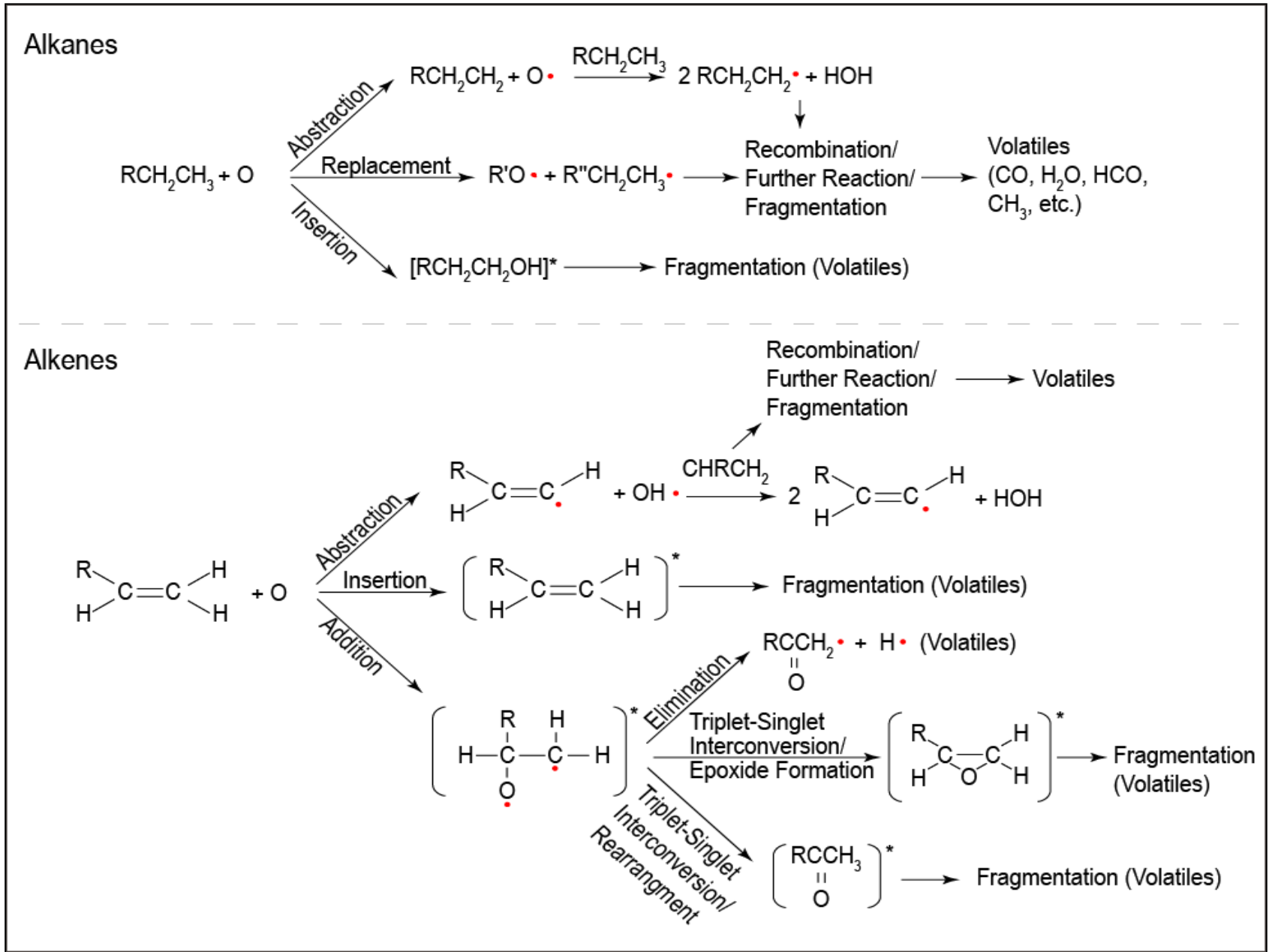


Atomic Oxygen Interactions with Hydrocarbons

All atomic oxygen reactions result in release of volatile oxidation products



Radio Frequency Plasma Ashers

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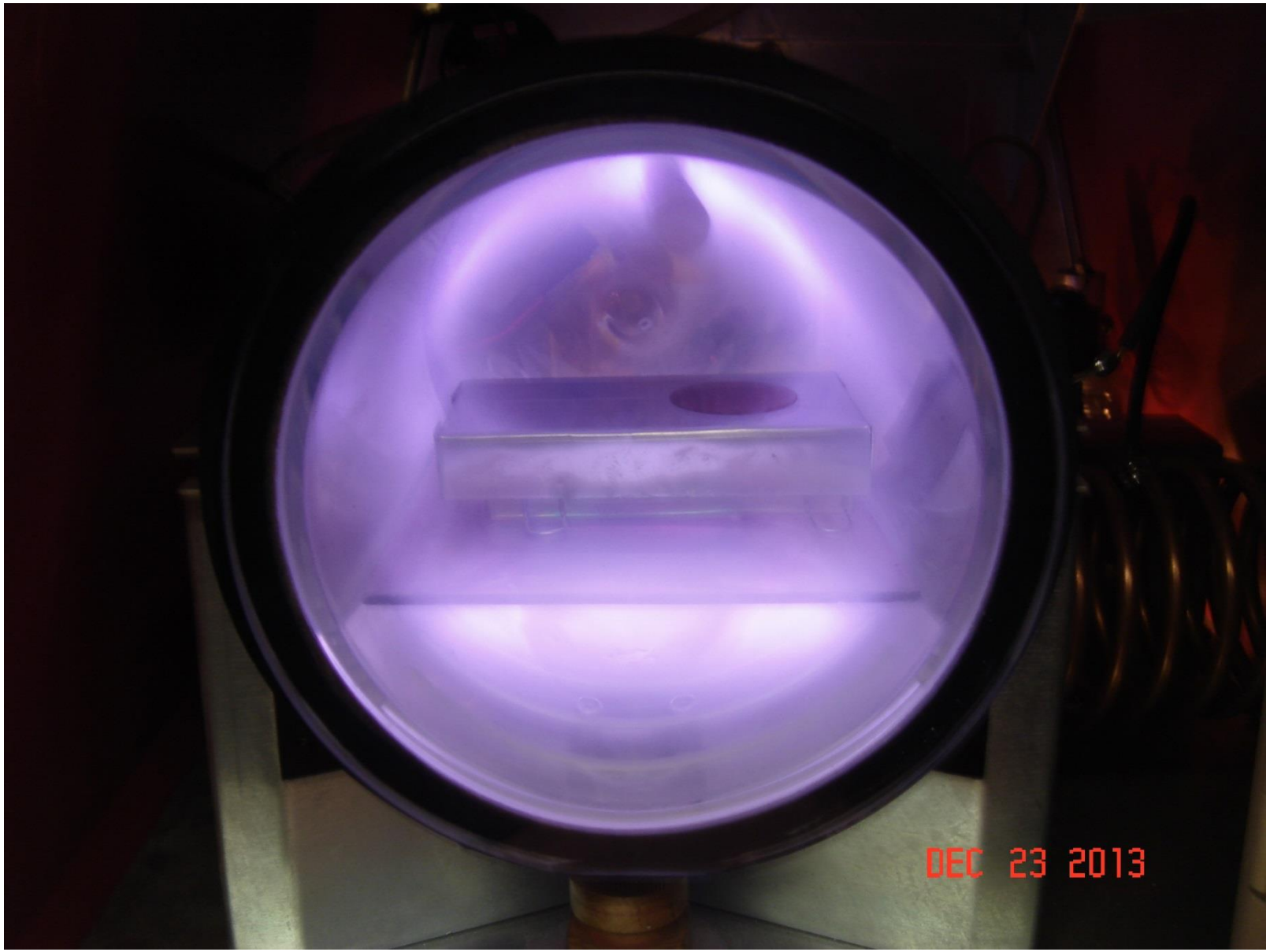
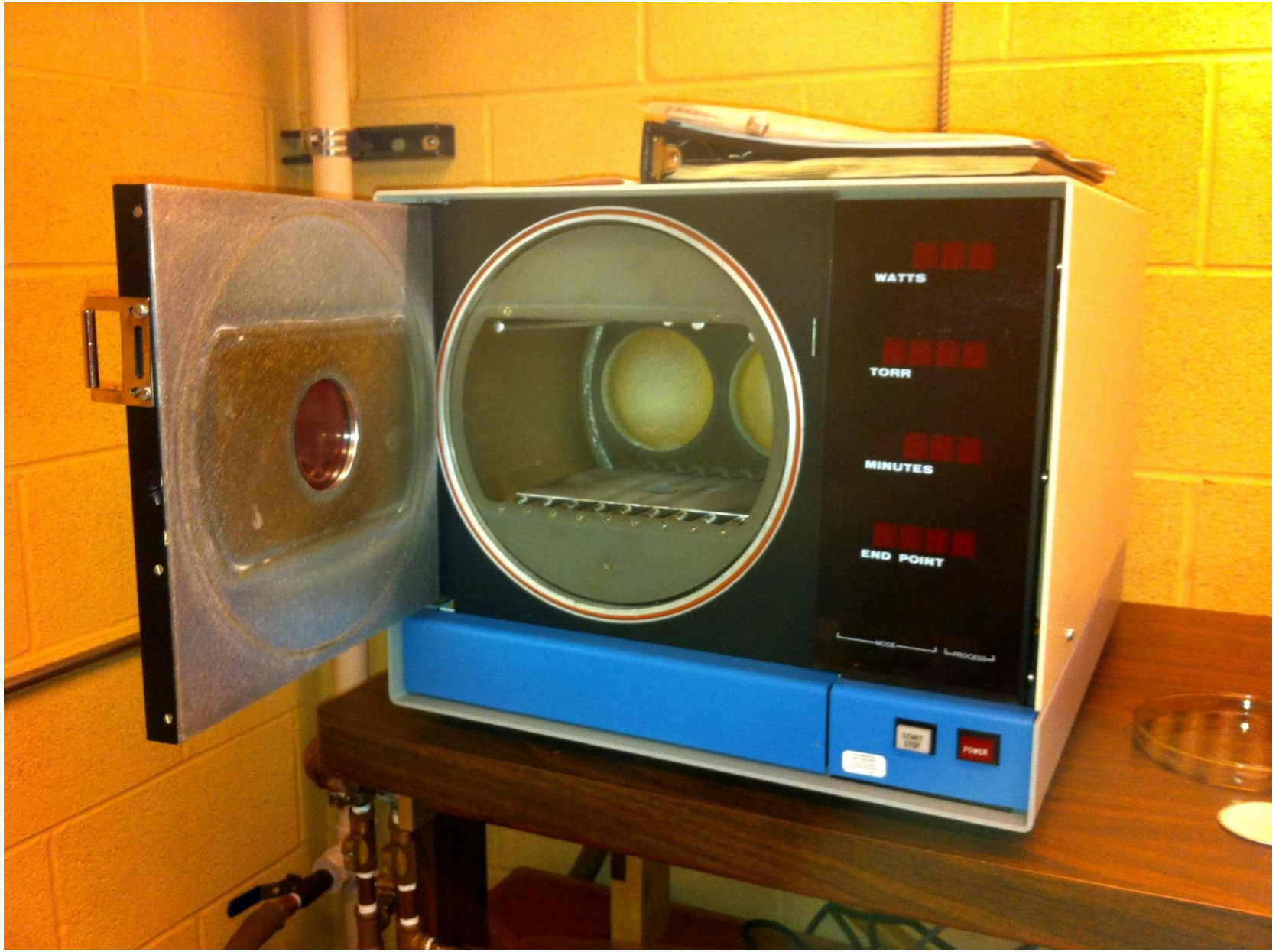


Radio Frequency Plasma Asher



Large Area Atomic Oxygen Exposure Facility

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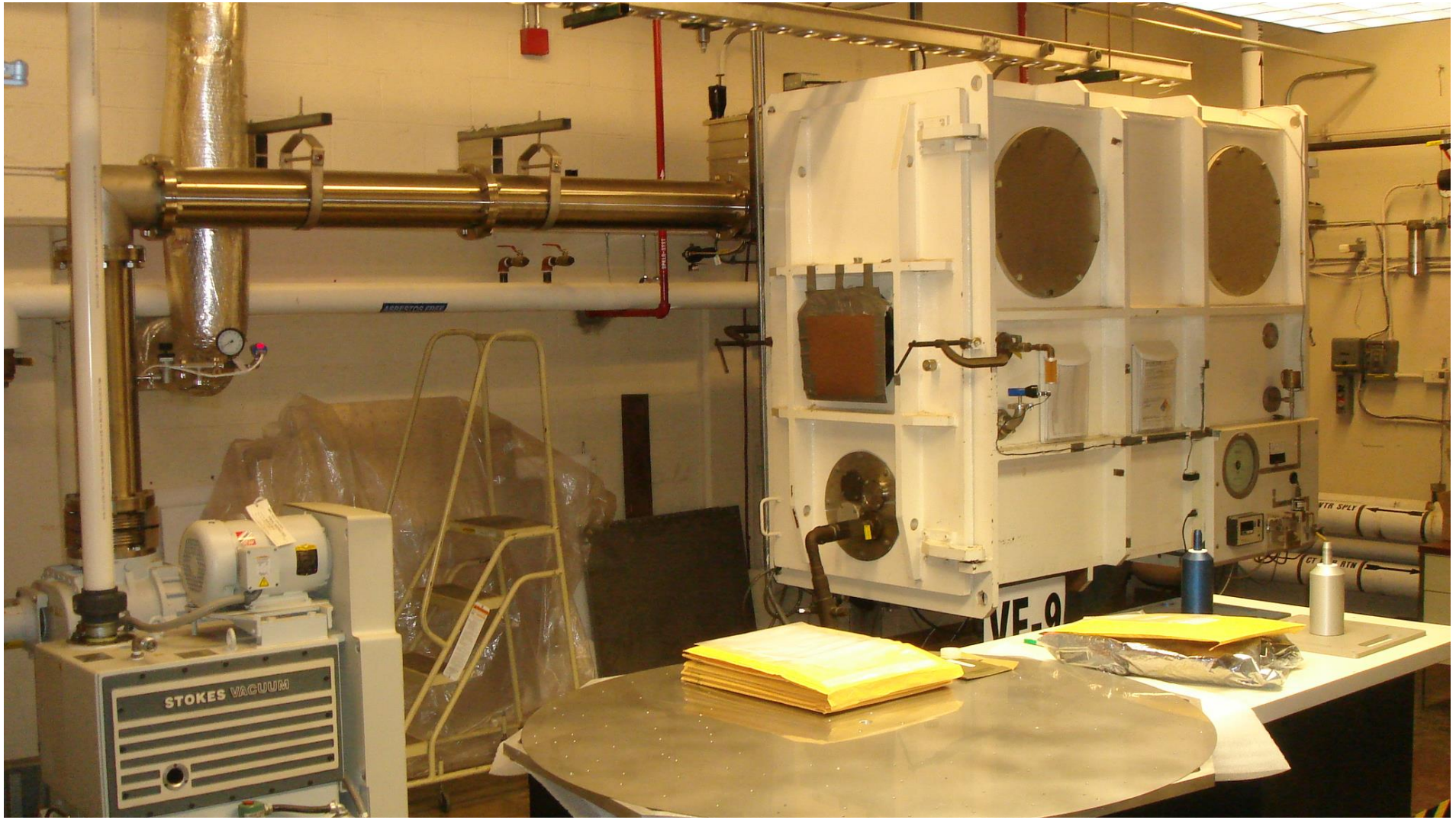
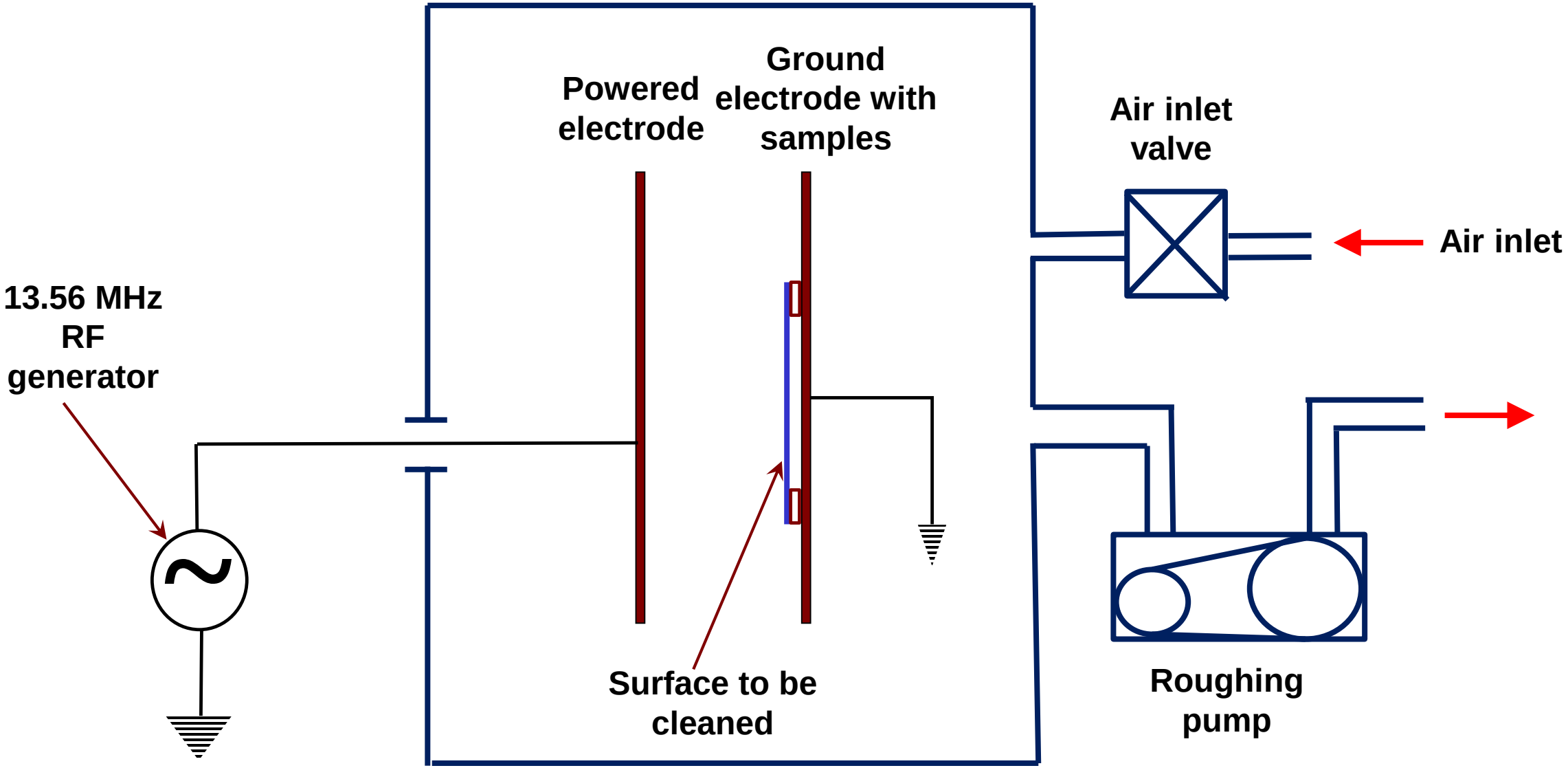
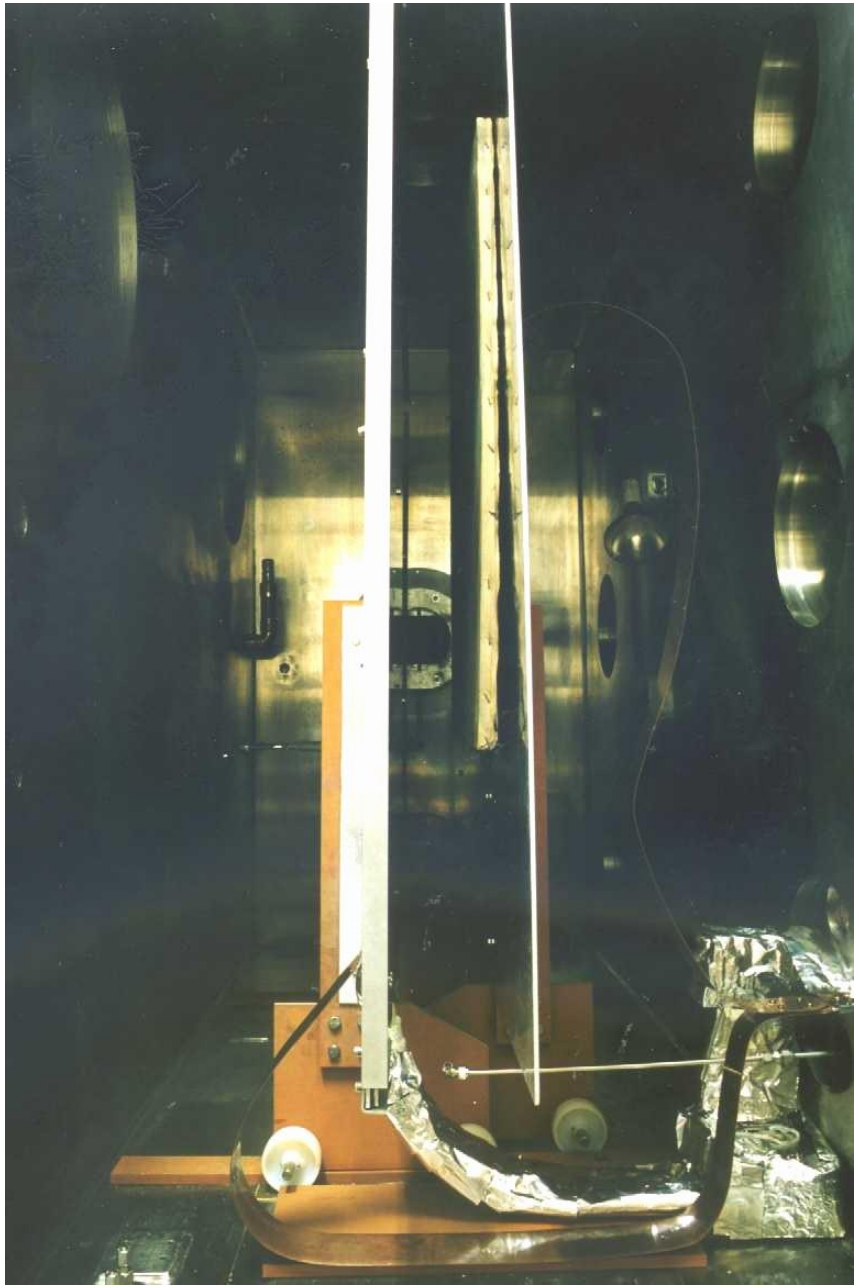


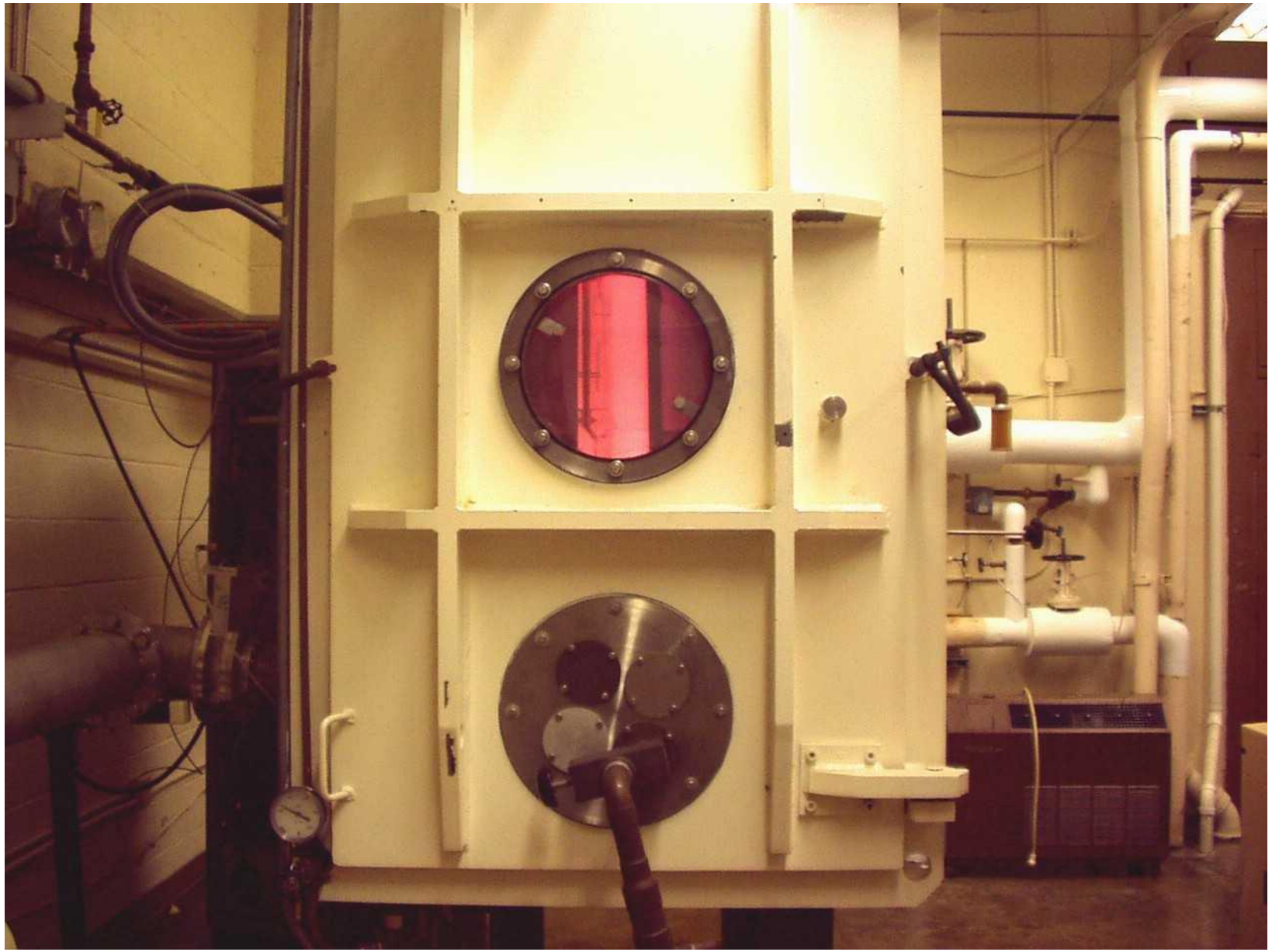
Schematic of Large Area Atomic Oxygen Exposure Facility



Exposure Configuration in Large Area Atomic Oxygen Exposure Facility



Radio Frequency Plasma in Large Area Atomic Oxygen Exposure Facility



Atomic Oxygen Art Restoration of Smoke Damaged Paintings

Before atomic oxygen cleaning

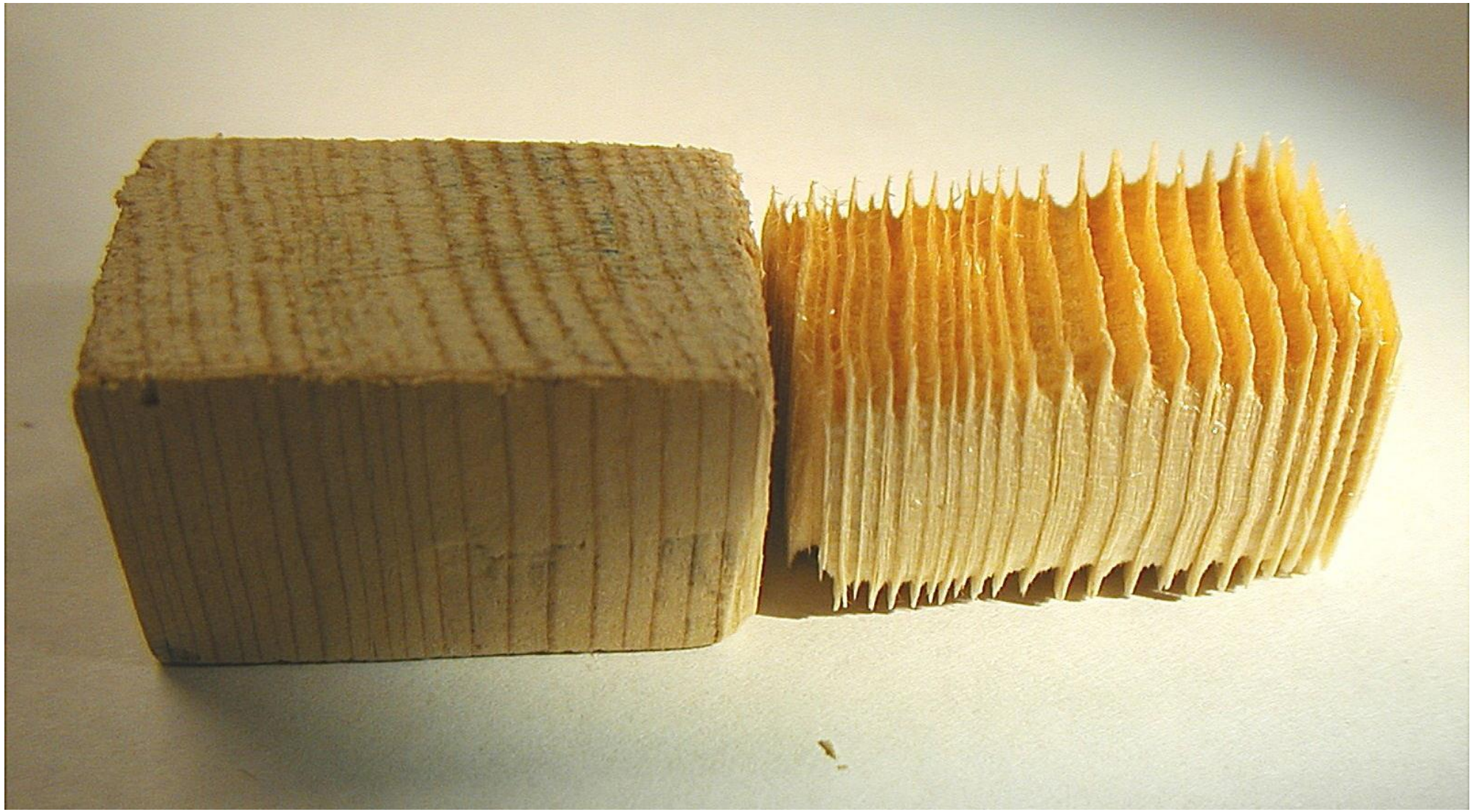
After atomic oxygen cleaning

Atomic Oxygen Art Restoration of Fire Damaged Paintings

Fire damaged

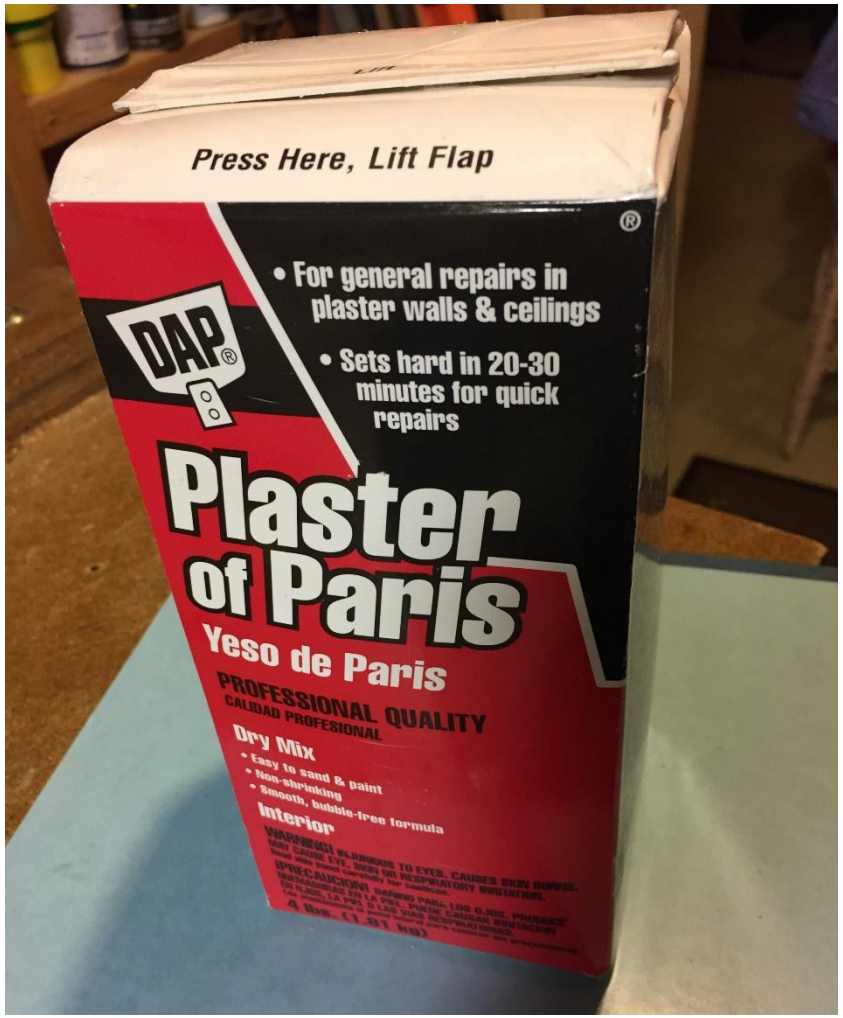
After atomic oxygen restoration

Pine



Untreated **Atomic oxygen etched**

Plaster Sample Preparation



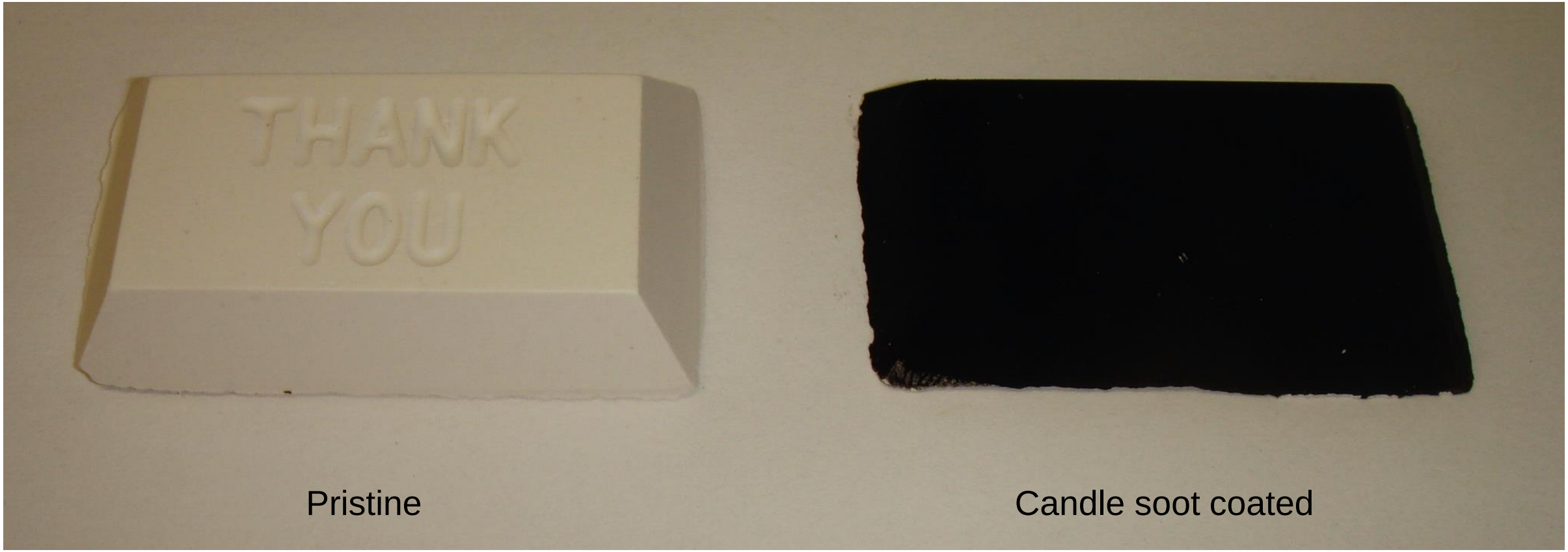
Plaster used

Plaster in molds

Plaster Sample

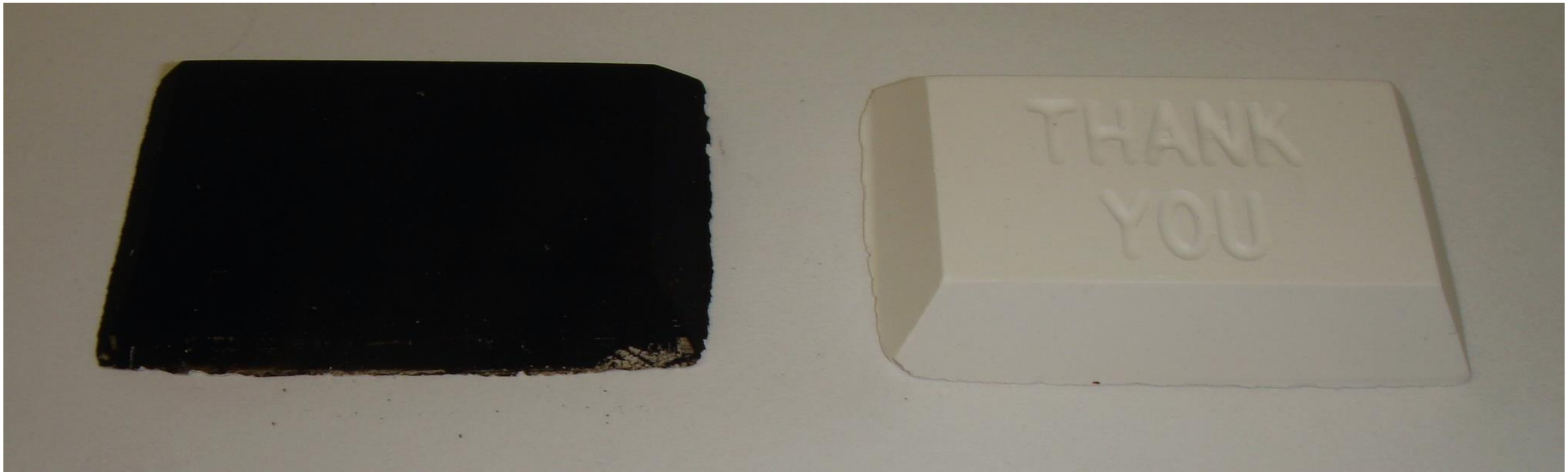
Plaster Sample Preparation

Plaster Sample Preparation



Plaster Sample Cleaning Results

Candle soot coated

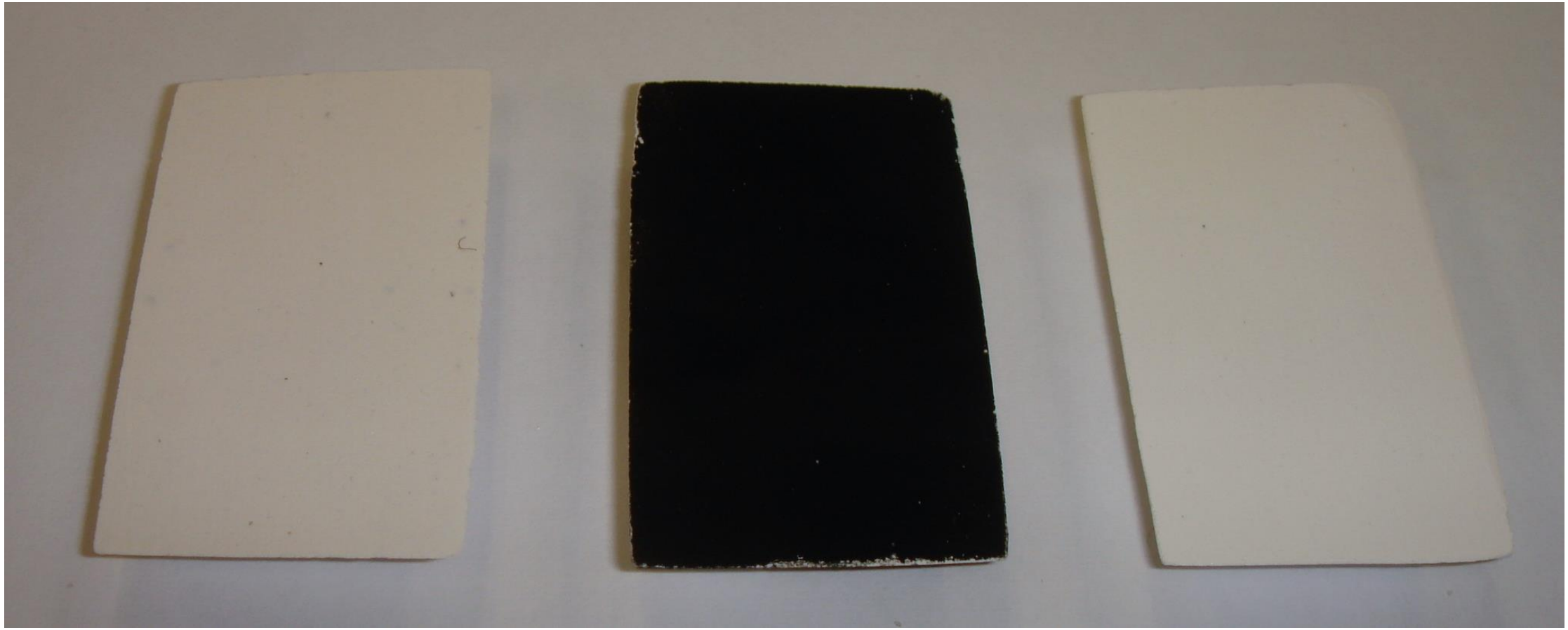


Before atomic oxygen cleaning

After atomic oxygen cleaning for 15.8 hours

Plaster Sample Cleaning Results

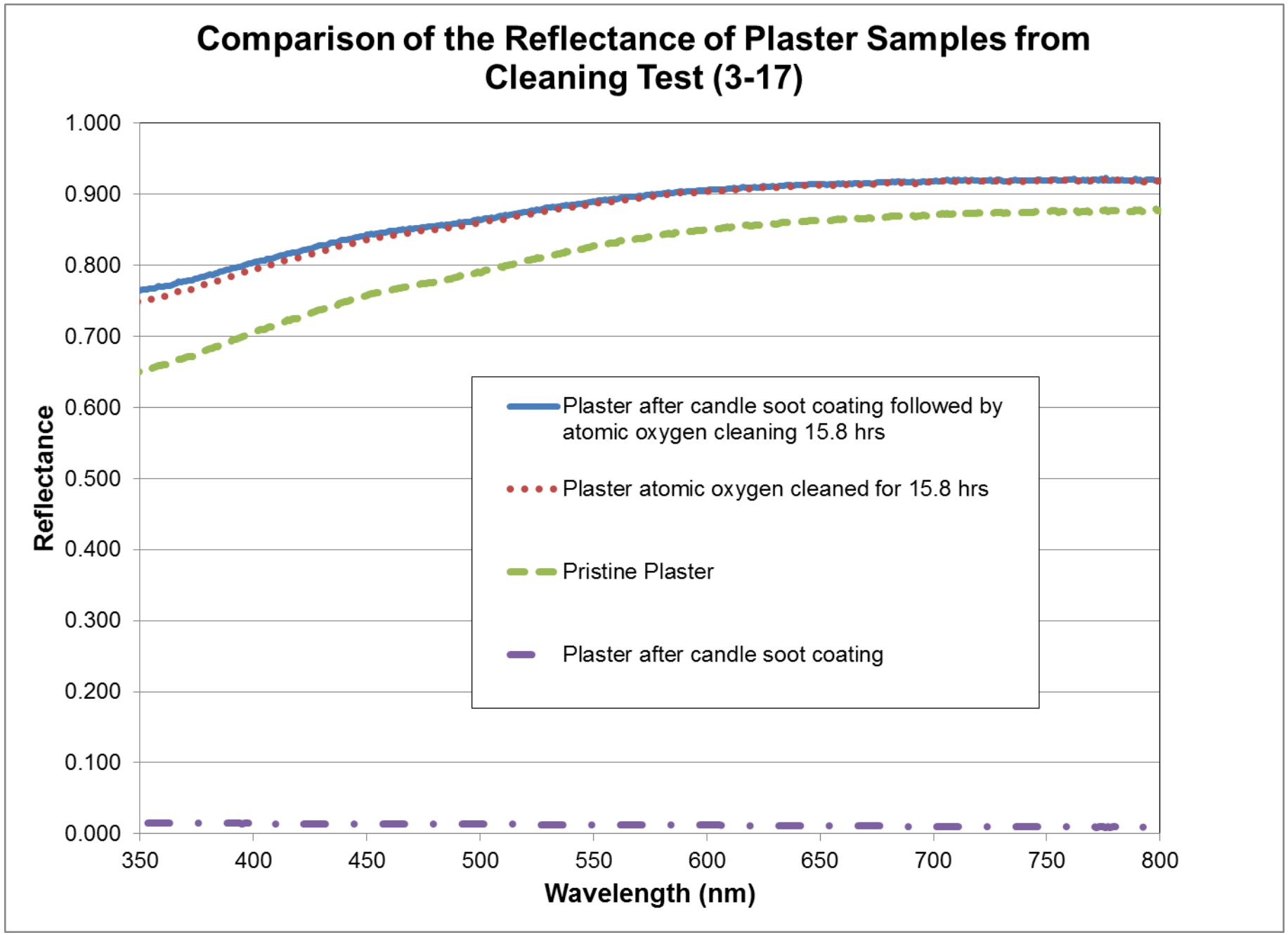
Candle soot coated on sanded back surface of samples



Pristine

Soot coated

After atomic oxygen cleaning
For 15.8 hours


Comparison of the Reflectance of Plaster Samples from Cleaning Test (3-17)
Reflectance
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
350
400
450
500
550
600
650
700
750
800
Wavelength (nm)
Plaster after candle soot coating followed by atomic oxygen cleaning 15.8 hrs
Plaster atomic oxygen cleaned for 15.8 hrs
Pristine Plaster
Plaster after candle soot coating

Plaster Sample Preparation

Rubbed with contaminants from automobile exhaust pipe

Rubbed with contaminants from automobile engine oil on engine block

Plaster Sample Preparation

Rubbed with contaminants from automobile exhaust pipe

Rubbed with contaminants from automobile engine oil on engine block

Plaster Sample Atomic Oxygen Cleaning Results

Before

After

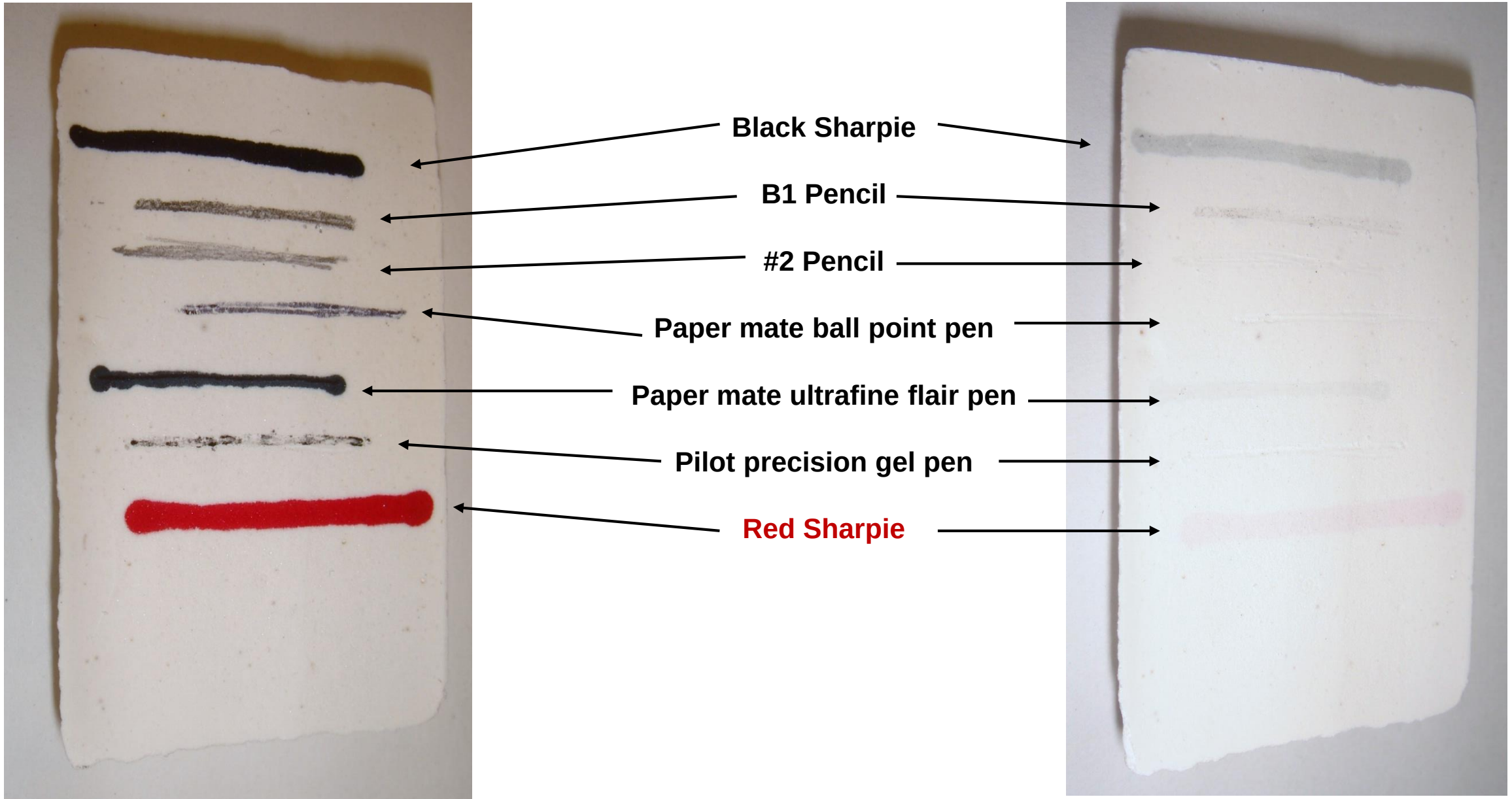
Rubbed with contaminants from automobile exhaust pipe

Rubbed with contaminants from automobile engine oil on engine block

Pencil and Pen Markings on Sanded Smooth Samples

Marked samples

After atomic oxygen cleaning



Summary

- Atomic oxygen appears ideally suited to remove hydrocarbon contamination from the surface of plaster sculptures.

- If the hydrocarbon contamination has inorganic content, atomic oxygen cleaning may leave some traces of inorganic residue on the surface.

- There is no abrasion to the plaster sculptures during cleaning with atomic oxygen.

- The highly reactive atomic oxygen is able to get around corners and into crevices

- The reaction products with pure hydrocarbons are simple dilute gases leaving no contamination on the surfaces of the plaster sculptures.

- The cleaning process can be stopped at any point so that a surface can be partially or fully cleaned in order to obtain the desired color on the surface.